Kindergarten Vaccination Coverage Survey

School Year 2016-2017

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Executive Summary

Overview

Vaccination records for children enrolled in a kindergarten class at Kansas public and private schools during the 2016-2017 school year were collected and vaccination coverage was evaluated. Statewide vaccination coverage levels were calculated and various factors [school type, county of residence, exemption status, and school policy regarding exclusion of non-up-to-date (UTD) children] assessed. Children who were between the ages of five and seven years were included in the study. In total, there were 297 schools; 260 public and 37 private, included and 6,748 records analyzed.

Vaccination Coverage for Kansas Kindergarteners

The statewide coverage levels for all vaccinations required at school entry were above 88%. HepB3 had the highest coverage with 96.5% of students vaccinated. DTaP4 and HepB3 were the only vaccinations which met the national goal [Healthy People (HP) 2020], with over 95% coverage among kindergarteners. The 5-4-2-2-3 (all vaccines required for school entry) series measures for all five required vaccinations and had a coverage level of 82.8%. A two percent increase in DTaP5, Polio4, MMR2, Var2 and 5-4-2-2-3 coverage rates was observed 30 days after school entry. The 2016-2017 coverage rates were compared to previous school year levels and MMR2, HepB3, and 5-4-2-2-3 rates were significantly lower; however, HepA2 rates were significantly higher. When coverage levels were examined by type of school (private v. public), public schools had a significantly higher percentage of kindergarteners vaccinated against Var2, 5-4-2-2-3 vaccine series, and HepA2.

Kansas counties were grouped based on population density (rural, moderately populated, and urban) and coverage levels assessed. Compared to urban, kindergarten students in rural counties had a significantly higher percentage of coverage for 5-4-2-2-3 and all recommended vaccinations [Hib3, PCV4, and HepA2]. Lastly, children in moderately populated counties had significantly lower rates of PCV4 coverage compared to any other group.

Exemptions and Exclusion Policies

Kansas allows two forms of vaccine exemption; religious and medical. The 2016-2017 school year saw 1.8% of kindergarten students reporting an exemption, a three year trend of year-over-year increase in exemption rates. The percentage of religious exemptions was 1.48%; significantly higher when compared to four years ago. Medical exemptions has remained unchanged at 0.3% since the 2010-2011 academic year.

Of the 549 schools which provided exclusion policy information, 436 (79.4%) indicated they had a policy to exclude children who are not UTD for vaccinations required for school entry. Vaccine coverage was analyzed by exclusion policy and it was observed that schools with an exclusion policy had higher vaccination rates for all required vaccinations, 5-4-2-2-3, Hib3, and PCV4 compared to schools without a policy to exclude non-UTD students.

Background

The Kansas Kindergarten Immunization Coverage Assessment is an annual survey conducted by the Kansas Department of Health and Environment (KDHE) to assess vaccination coverage among kindergarten students. The population for this study included kindergarten students between the ages of five and seven years on the first day of the academic year and enrolled in either a public or private school in Kansas.

The Advisory Committee for Immunization Practices (ACIP) recommends children by 5 years of age receive (Table 1):

- 5 doses of diphtheria, tetanus, and acellular pertussis vaccine (DTaP5)
- 3 doses of hepatitis B vaccine (HepB3)
- 3 doses of *Haemophilus influenzae* type b vaccine (Hib3)
- 2 doses of measles, mumps, and rubella vaccine (MMR2)
- 4 doses of pneumococcal conjugate vaccine (PCV4)
- 4 doses of polio vaccine (Polio4)
- 2 doses of hepatitis A vaccine (HepA2)

DTaP was first licensed in 1996. By 1998 ACIP recommended administration of DTaP instead of the diphtheria, tetanus and whole cellular pertussis (DTP) vaccine for immunization due to fewer reactions[1]. Kansas requires all children entering kindergarten have five doses of DTaP, with proof of immunization provided to school prior to first day of attendance[2]. Four doses of DTaP is acceptable if the fourth dose was given on or after the child's fourth birthday. Hepatitis B vaccine was first licensed in 1981 and by 1991 ACIP recommended administration of this vaccine to all infants. In 2004 Kansas required all children entering kindergarten have three doses of hepatitis B vaccine. Measles, mumps, and rubella vaccine was first licensed in 1971, two doses of this vaccine was recommended for all school-aged children by 1989. Kansas requires children to receive two doses prior to entering kindergarten. Polio vaccine was first licensed in 1955 and later that year doses were distributed throughout the United States. Kansas requires all children entering school to have four doses of polio vaccine. Three doses are acceptable if the third dose was given on or after the child's fourth birthday. Varicella vaccine was first licensed in 1995. By 2006 ACIP recommended a two-dose varicella vaccine for all children. Kansas requires children entering kindergarten to have two doses of varicella vaccination. Hepatitis A vaccine was first licensed in 1995 and in 2006 ACIP recommended administration of this vaccine to all children[3]. In 2009 Kansas required those in childcare have two doses of hepatitis A vaccine; however, it is not required for entry into

[1] Preventing Tetanus, Diphtheria, and Pertussis Among Adolescents: Use of Tetanus Toxoid, Reduced Diphtheria Toxoid and Acellular Pertussis Vaccines Recommendations of the Advisory Committee on Immunization Practices (ACIP)

[2] Immunization Action Coalition. State Information State mandates on immunization

[3] Epidemiology and Prevention of Vaccine-Preventable Diseases. 13th ed.

kindergarten. *Haemophilus influenzae* type B vaccine was first licensed in 1985. In 1991 ACIP recommended it for infants beginning at two months of age. Hib3 is not required for entry into kindergarten. Pneumococcal conjugate vaccine was first licensed in 1977. In 2000, it was licensed for use in infants and by 2010 ACIP recommended for infants starting at two months of age, however, Kansas does not require PCV4 for kindergarten entry.

Table 1: ACIP Birth to 6 Years Immunization Recommendations

		Requirement for School	Number of Doses	Healthy People 2020 Coverage Goals
DTaP5	Diphtheria, Tetanus, Pertussis	Yes	5	95%
DTaP4*			4	
HepB3*	Hepatitis B		3	
MMR2*	Measles, Mumps, Rubella		2	
Polio4	Polio		4	
Polio3*			3	
Var2*	Varicella	Yes (or history of disease)	2	
5-4-2-2-3	DTaP5, Polio4, MMR2, Var2, Hep3			
HepA2	Hepatitis A	Recommended	2	85%
Hib3	*Haemophilus influenzae* type b		3	90%
PCV4	Pneumococcal conjugate vaccine		4	

In the state of Kansas, two legal alternatives to required vaccination are permissible, medical and religious exemptions.[4] To receive a medical exemption, a physician must annually sign a form stating the reason for exemption and from which vaccine(s) the child is exempt. To receive a religious exemption, a parent or guardian must write a statement explaining that the child is an adherent of a religious denomination whose religious teachings are opposed to such tests or inoculations. Additionally, a separate statute (K.S.A. 72-5211a) allows schools to exclude students from school who do not have the required vaccinations or an acceptable exemption. However, it is entirely up to each school board as to whether or not to enforce this statue until a child comes into compliance for required vaccinations.

[4] Statute 72-5209: Same; certification of completion required, alternatives; duties of school boards. (a) In each school year, every pupil enrolling or enrolled in any school for the first time in this state, and each child enrolling or enrolled for the first time in a preschool or day care program operated by a school, and such other pupils as may be designated by the secretary, prior to admission to and attendance at school, shall present to the appropriate school board certification from a physician or local health department that the pupil has received such tests and inoculations as are deemed necessary by the secretary by such means as are approved by the secretary. Pupils who have not completed the required inoculations may enroll or remain enrolled while completing the required inoculations if a physician or local health department certifies that the pupil has received the most recent appropriate inoculations in all required series. Failure to timely complete all required series shall be deemed non-compliance. (b) As an alternative to the certification required under subsection (a), a pupil shall present: (1) An annual written statement signed by a licensed physician stating the physical condition of the child to be such that the tests or inoculations would seriously endanger the life or health of the child, or (2) a written statement signed by one parent or guardian that the child is an adherent of a religious denomination whose religious teachings are opposed to such tests or inoculations. (c) On or before May 15 of each school year, the school board of every school affected by this act shall notify the parents or guardians of all known pupils who are enrolled or who will be enrolling in the school of the provisions this act and any policy regarding the implementation of the provisions of this act adopted by the school board. (d) If a pupil transfers from one school to another, the school from which the pupil transfers shall forward with the pupil's transcript the certification or statement showing evidence of compliance with the requirements of this act to the school to which the pupil transfers.

Methods

Immunization Coverage Analysis

Sampling and Data Collection

Each Kansas public and private school with a kindergarten class received a letter requesting participation in this study. These letters, co-signed by the Secretary of KDHE and the Commissioner of the Kansas State Department of Education (KSDE), specified the number of records requested based upon a simple random sampling methodology and kindergarten enrollment population. This sampling was used to ensure adequate sample size for each Kansas County. Sampling weights were calculated based on county size, enrollment, and school type (public or private). Schools were assigned to one of three groups:

- Schools that sent 30 vaccination records selected at random
- Schools that sent all vaccination records
    - For schools with less than 30 kindergarten students
- Schools that sent no vaccination records

These record requests could include exemptions based on how records were requested to be selected . Participating schools submitted Kansas Certificates of Immunizations (KCIs) or any other form of paper vaccination records, including printouts from computerized record keeping programs, to KDHE. All personal identifiers were removed from each record, except date of birth, to ensure confidentiality. This sampling methodology is different from assessments prior to the 2014-2015 school year, so data from previous years cannot be utilized for comparison. To be included in analysis, data had be received by cut-off date indicated on the participation letter; additionally, data was not be utilized if date of birth was missing or date of vaccine administration was illegible.

Data Analysis

Total population included children with date of birth on the vaccination record that met age requirements for inclusion. Data was weighted, point estimates of coverage levels, and 95% confidence intervals (95% CI) were analyzed for:

1. Vaccinations required for school
    - DTaP5, Polio4, MMR2, HepB3 and Var2
2. Vaccinations recommended for school
    - Hib3, PCV4 and HepA2
3. Healthy People 2020 (HP2020) objectives
    - DTaP4 and Polio3

If a child had a fourth dose of DTaP on or after the fourth birthday, he/she was considered UTD for DTaP5 school requirement. Additionally, a child was considered UTD for Polio4 if he/she had a third dose of the vaccine on or after their fourth birthday. Furthermore, children who indicated history of varicella disease were not included in the analysis for varicella vaccine coverage. This methodology was utilized due to the date of disease not being consistently recorded. Vaccination exemptions were classified as medical or religious.

Analyses were performed at school entry and stratified by school type, county population density and differences in sampling ratios between counties. Sample weights were calculated using the number of kindergartners enrolled in a county and the number of records analyzed for that county. Each county was categorized based on population densities, and for the purpose of this analysis, grouped into "urban" (≥150 persons per square mile), "moderately populated" (20-149.9 persons per square mile), and "rural" (≤19.9 persons per square mile) (Appendix 1). Vaccination coverage level estimates were compared among these groups.

Exemption and Exclusion Policy Analysis

Data Collection

Each Kansas public and private school with a kindergarten class received a letter requesting participation in this study. These letters, co-signed by the Secretary of KDHE and the Commissioner of the KSDE, requested schools to complete a form or online survey listing:

- Total number of kindergarten students enrolled
- Total number of kindergarten students with exemptions to vaccination by type (religious or medical)
    - Students with exemption to all vaccines
    - Students with exemption, who have one or more vaccinations

Additionally, schools were asked to complete a two-question survey assessing exclusion policies and procedures.

Data Analysis

Exemption data was collected on the total number of kindergarten students enrolled who had any type of exemption and were classified by type (religious or medical). All exemptions were analyzed by school type (public or private) and county population density group (rural, moderately populated, or urban).

School policy data was collected regarding enforcement of K.S.A. 72-5211a and policies were stratified by school type.

Data regarding school exclusion policies were linked with vaccination records from corresponding schools utilized in the coverage assessment analysis. Point estimates of coverage levels and 95% CIs at school entry were calculated for the coverage assessment analysis and were stratified by school exclusion policy. For schools that reported no exclusion policy in place, reasons were assessed.

Results

Coverage Assessment Analysis

Data Collection

Letters of invitation to participate in the coverage assessment and provide vaccination records were sent to 372 Kansas schools; 316 public schools and 56 private, in 105 counties in Kansas. Seventy-five schools (20.2%) did not respond, did not respond in time, or provided unusable data. The remaining 297 (79.8%) schools (260 public and 37 private) responded to the data request and were included in analysis. A total of 6,955 vaccination records from the 297 schools were included in analysis, which equated to one record representing 5.5 students enrolled in participating schools.

The sample population for the 2016-2017 school year distribution across Kansas was 37.2% in rural counties, 48.4% in moderately populated counties, and 14.5% in urban counties. After weighting, the number of records included in the analysis were: Rural: 2,507 (31.2%) Moderately populated: 3,263 (51.6%) Urban: 978 (17.2%)

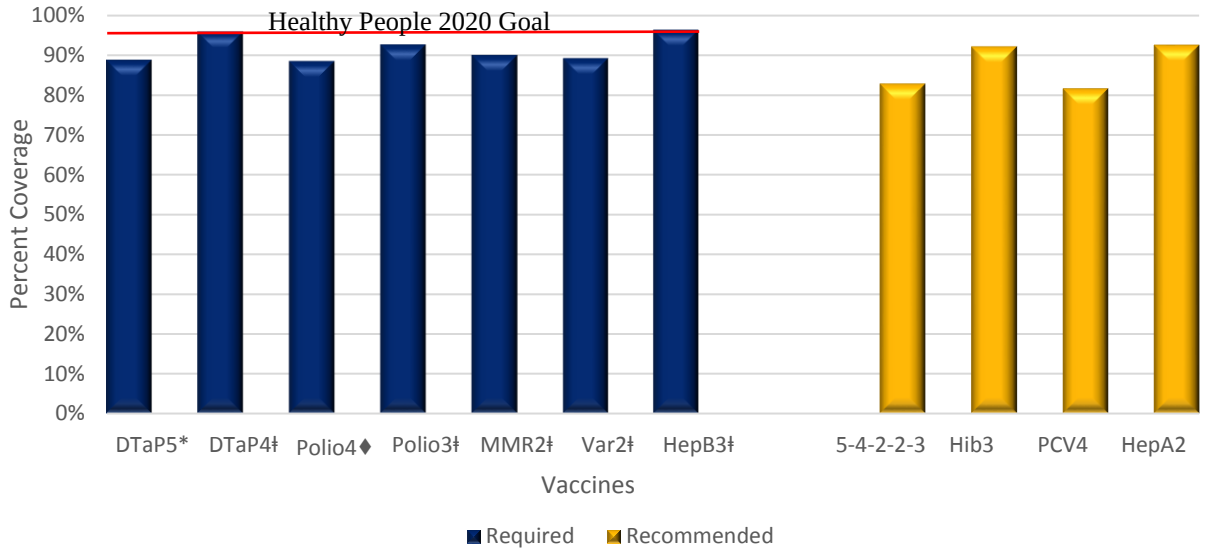
Kindergarten Vaccination Coverage

Statewide Vaccination Coverage

The vaccination coverage levels at school entry for all required vaccinations (DTaP5, Polio4, MMR2, Var2, and HepB3) were above 88%, with HepB3 having the highest coverage at 96.5%. The complete series for all five required vaccinations (5-4-2-2-3) had a coverage level of 82.8%. Polio4 had the lowest coverage among required vaccinations with 88.6% of children being considered UTD. Of the vaccinations not required for school entry, PCV4 had the lowest coverage with 81.6% of kindergartners being fully vaccinated at school entry. DTaP4 (96.0%) and HepB3 (96.5%) coverage met the HP2020 national metrics (Figure 1).

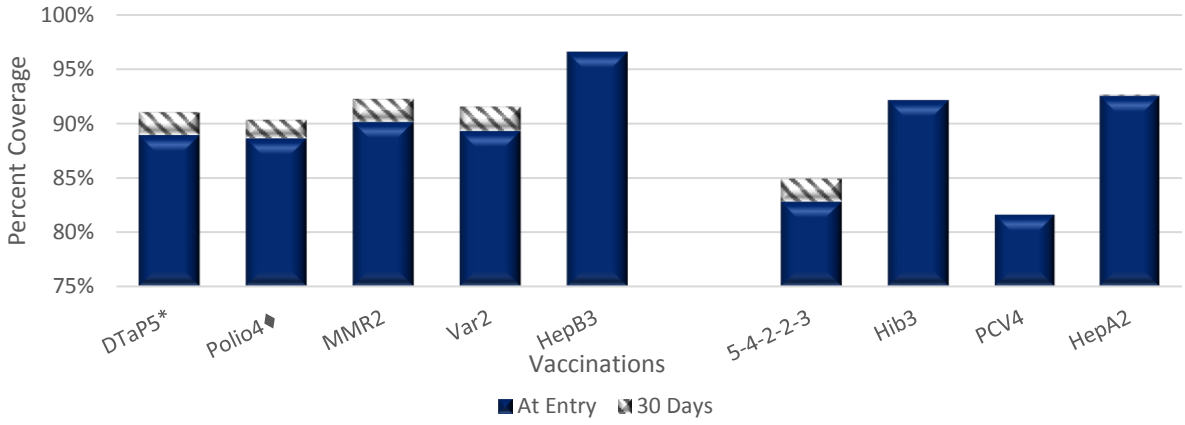
Vaccination coverage was assessed 30 days after the start of school to measure changes, if any, in coverage rates. An increase of approximately 2% was observed for DTaP5, Polio4, MMR2, Var2, and the 5-4-2-2-3 vaccine series (Figure 2). A negligible increase of 0.1% for HepA2 was also observed. No change was observed for HepB3, Hib3, and PCV4 coverage 30 days after school entry.

Figure 1: Statewide vaccination coverage levels of kindergarten students at school entry by vaccine, Kansas, 2016-2017



**5 doses of DTaP or 4 doses if the fourth is administered on or after the fourth birthday.*
♦4 doses of Polio or 3 doses if 3rd is administered on or after the fourth birthday
‡ Healthy People 2020 objective

Figure 2: Statewide vaccination coverage levels of kindergarten students 30 days after school entry by vaccine, Kansas, 2016-2017

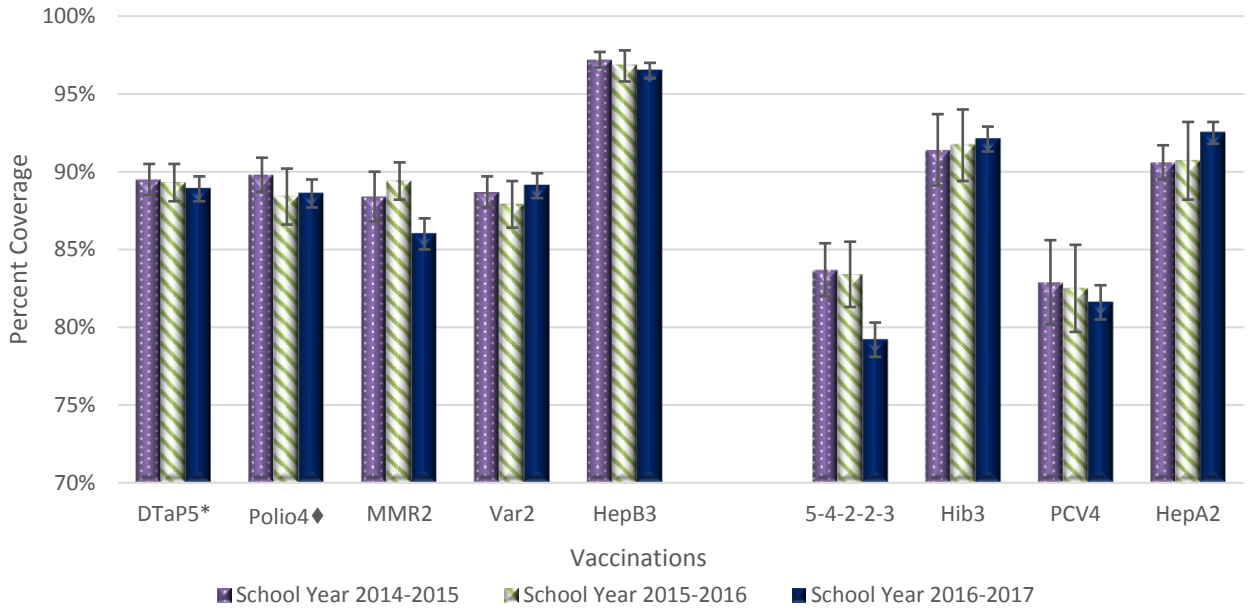


**5 doses of DTaP or 4 doses if the fourth is administered on or after the fourth birthday.*

♦4 doses of Polio or 3 doses if 3rd is administered on or after the fourth birthday

Vaccination coverage among Kansas kindergarten students at school entry was compared to levels from the previous academic years. Comparisons revealed a year-over-year decrease in coverage for HepB3, levels in 2016-2017 academic year were significantly lower than 2014-2015. MMR2 and 5-4-2-2-3 vaccine series were significantly lower in 2016-2017 than previous analyzed years. Alternatively, a significant increase in HepA2 was observed in 2016-2017 compared to the 2014-2015 school year. There were no significant changes in the vaccination coverage levels for any other vaccinations (Figure 3).

Figure 3: Statewide vaccination coverage levels of kindergarten students at school entry by vaccine, Kansas, 2014-2015 through 2016-2017



**5 doses of DTaP or 4 doses if the fourth is administered on or after the fourth birthday.*
♦4 doses of Polio or 3 doses if 3rd is administered on or after the fourth birthday

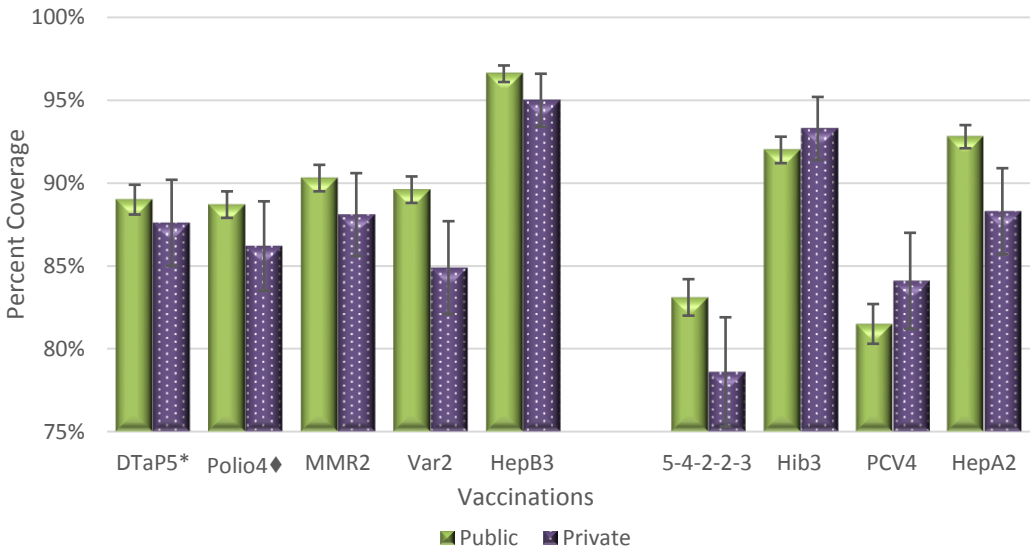
Vaccination Coverage Stratified by School Type (Public vs. Private)

Differences were observed in vaccination coverage levels among kindergartners enrolled in public versus private schools (Figure 4). When compared to children enrolled in private schools, students in public schools had significantly higher vaccination coverage for:

- Var2
- 5-4-2-2-3 vaccine series
- HepA2

There were no other significant differences in vaccination coverage observed between school types.

Figure 4: Vaccination coverage levels of kindergarten students at school entry by vaccine and school type, Kansas 2016-2017



**5 doses of DTaP or 4 doses if the fourth is administered on or after the fourth birthday.*
♦4 doses of Polio or 3 doses if 3rd is administered on or after the fourth birthday

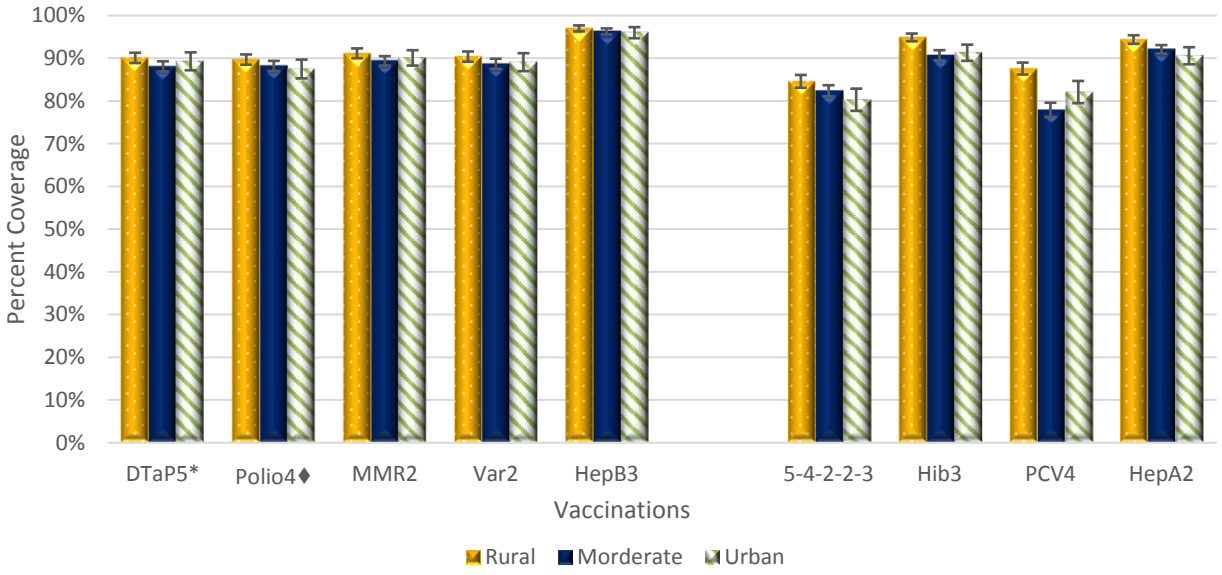
Vaccination Coverage Stratified by County Population Density Group

After counties were stratified by population densities and coverage levels assessed, differences in immunization rates were observed (Figure 5). Compared to kindergarteners in urban counties, students in rural counties had significantly higher coverage for:

- 5-4-2-2-3 vaccine series
- All recommended vaccinations
    - Hib3
    - PCV4
    - HepA2

Additionally, children in moderately populated counties had a significantly higher level of PCV4 coverage compared to children residing in counties of other population densities.

Figure 5: Vaccination coverage levels for kindergarten students, by vaccine and county population density group, Kansas, 2016-2017



**5 doses of DTaP or 4 doses if the fourth is administered on or after the fourth birthday*
♦4 doses of Polio or 3 doses if 3rd is administered on or after the fourth birthday

Vaccination coverage was also analyzed at the county level and rates are listed by county name in Appendix 2. Maps of vaccine coverage by county are in Appendix 3.

Exemption and Exclusion Policy Analysis

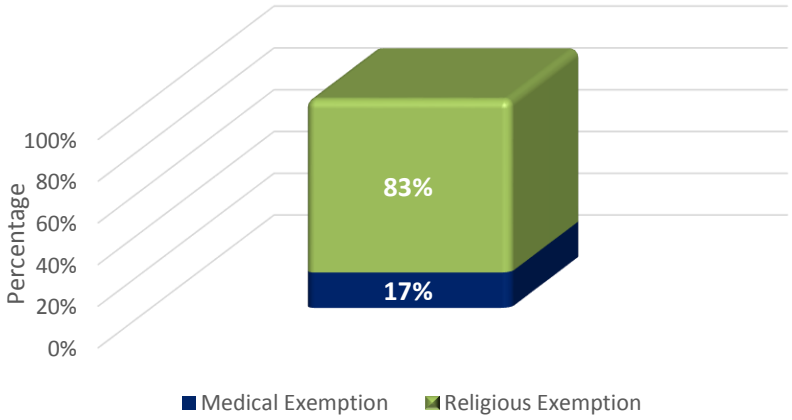
Data Collection

Of the 815 schools invited to participate, 550 (67.5%); 500 public and 50 private, responded to the request for information regarding exemption data. These responding schools represented 90 of the 105 Kansas counties and were included in the analysis.

Kindergarten Exemptions

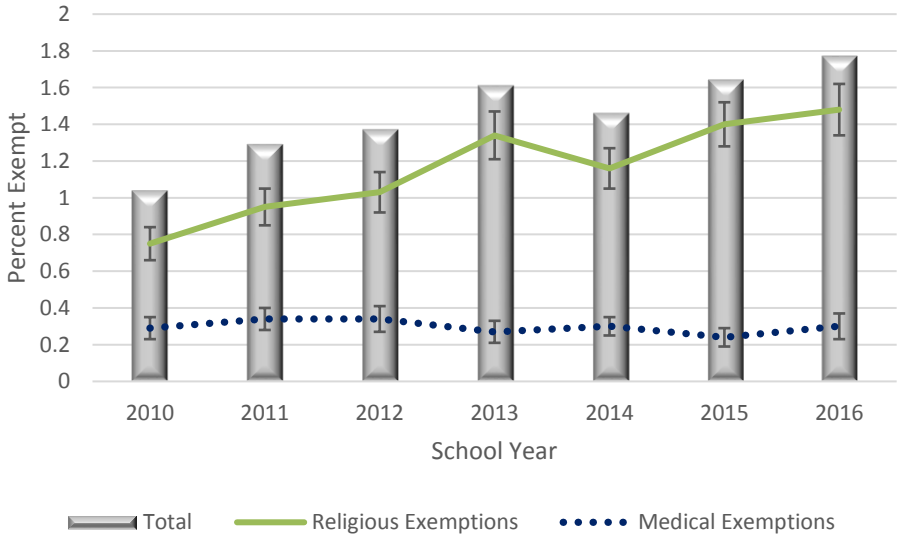
During the 2016-2017 school year, 477 (1.8%) kindergartners from the responding schools reported having an exemption. Of the exemptions reported, 398 (83.4%) were categorized as religious and 79 (16.6%) as medical (Figure 6).

Figure 6: Percentage of exemptions by exemption type, Kansas, 2016-2017



The percentage of kindergarten students which reported an exemption increased from 1.6% in the 2015-2016 school year to 1.8% in 2016-2017. This increase was not significant; however, this is the third year of increase in statewide vaccine exemptions (Figure 7). Religious exemptions increased, from 1.40% in 2015-2016 academic year to 1.48% in 2016-2017, while not a significant increase, this was significantly greater than those observed just four years ago in 2012-2013. Alternatively, medical exemption levels have not significantly changed since the 2010-2011 school year; remaining at approximately 0.3%.

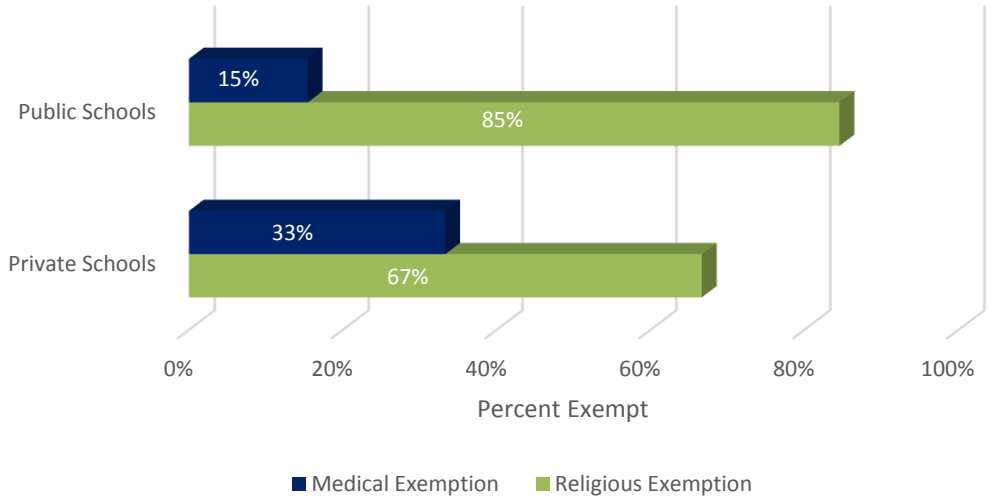
Figure 7: Exemption rates among kindergarten students, by exemption type and year, Kansas, 2010-2016



When stratified by school type, a higher proportion of overall exemptions as well as religious exemptions were observed among public schools. Private schools had a higher proportion of medical exemptions among their

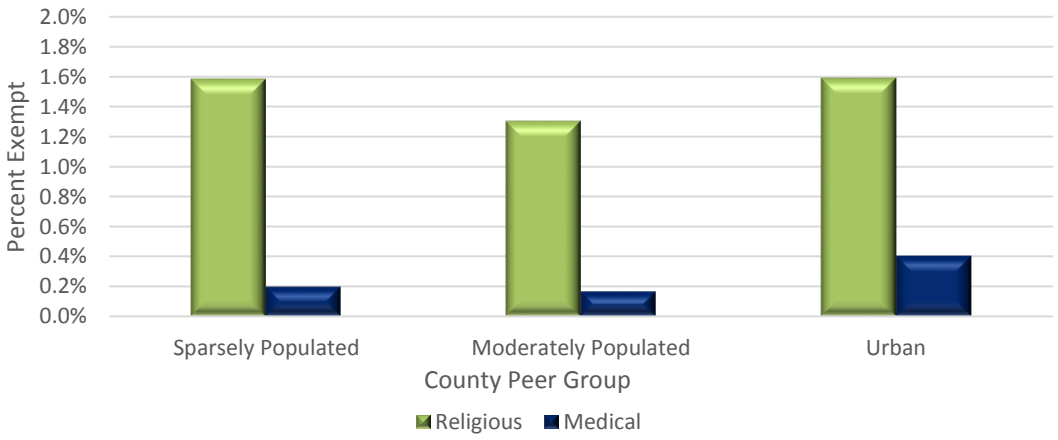
students compared to public schools, 33.3% vs 15.4% respectively (Figure 8). Alternatively, public schools had a higher proportion of religious exemptions compared to private schools, 84.6% vs 66.7% respectively.

Figure 8: Percentage of exemptions by exemption and school type, Kansas, 2016-2017



Vaccination exemption was stratified by county density group to identify trends. Urban and rural counties had the highest percent of total enrollment with religious exemptions at 1.58% each (Figure 9). However, urban counties had nearly double the proportion of medical exemptions at 0.40% compared to other county types. Conversely, moderately populated counties had the lowest percent of kindergarten students with a religious exemption and lowest proportion with a medical exemption, 1.30% and 0.17% respectively. When examined by county, religious exemptions were most prevalent in the eastern half of Kansas while medical exemptions greater than 0.1% were sparse and spread throughout. Maps of vaccine coverage by county are in Appendix 4.

Figure 9: Percentage of total population of kindergarten students with exemption by county population density group and exemption type, Kansas, 2016-2017



School Exclusion Policy

Schools were surveyed about policies for excluding non-UTD students.

Of the 550 schools included in analysis, 549 (99.8%) indicated their school's exclusion policy:

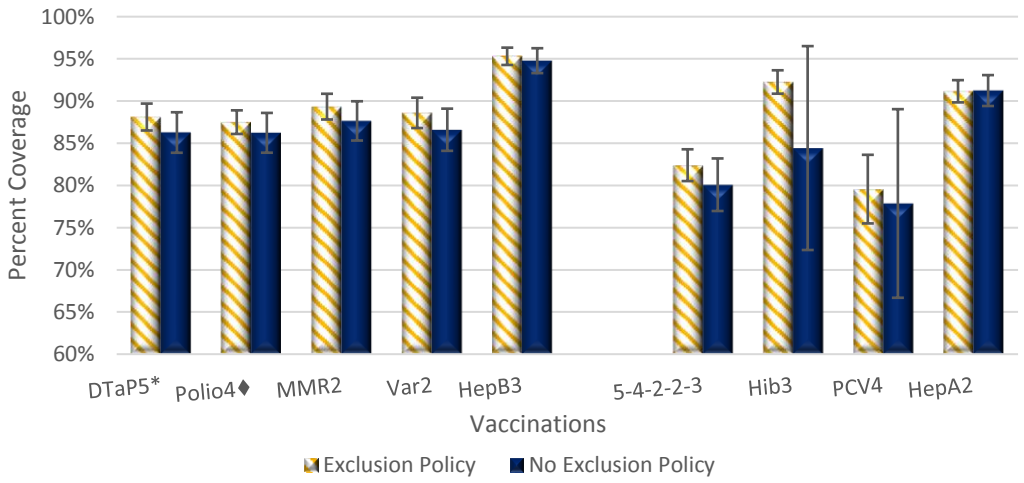
- 436 (79.4%) schools indicated they had an exclusion policy
- 97 (17.7%) schools indicated they did not have an exclusion policy
- 16 (2.9%) schools indicated they were unsure of their school's exclusion policy

Of the 549 schools who responded about their exclusion policy, 499 were public schools and 50 were private. When stratified by school type, 405 (81.1%) of public schools indicated exclusion of non-UTD students versus 31 (62.0%) of private schools.

Vaccination Coverage Stratified by School Exclusion Policy

There were 225 of the 549 schools also provided vaccination records for the coverage assessment; a majority, 154 (68.4%) schools, reported a policy for exclusion of non-UTD children. When vaccination coverage was stratified by exclusion status, it was observed that compared to schools that did not exclude, schools that reported an exclusion policy had proportionally higher vaccination coverage levels for all required vaccinations, the 5-4-2-2-3 series, Hib3, and PCV4 (Figure 10).

Figure 10: Vaccination coverage of kindergarten students by vaccine and school exclusion policy, Kansas, 2016-2017



**5 doses of DTaP or 4 doses if the fourth is administered on or after the fourth birthday*
♦4 doses of Polio or 3 doses if 3rd is administered on or after the fourth birthday

Schools that reported not having an exclusion policy in place were asked to provide a reason and it was observed that a 33.0% (32) stated it was because students would miss too much school and the school would lose funding.

Other common reasons included lack of support by administration for an exclusion policy and providing students with a grace period for students to become UTD.

Discussion

All vaccinations required for school entry were above 88% coverage for Kansas kindergartners for the 2016-2017 school year. DTaP4 and HepB3 were the only vaccinations that met the HP2020 goal of at least 95% coverage. Coverage levels for DTaP5, Polio4, MM2, Var2, and the 5-4-2-2-3 series each increased approximately 2% in the 30 days following the start of school. No increases in vaccination coverage for Hib3, HepA2, or PCV4 were noted. However, these vaccines are not being required for school may not be consistently documented on vaccination records causing an underreporting of true coverage levels. HepB3 also did not increase in this 30-day time frame due to the vaccination coverage level on the first day of school (96.5%) being the highest of any vaccine assessed.

Vaccination coverage levels between types of school (public vs private) and counties (rural vs moderately populated vs urban) were compared to determine if there was a difference in rates. Children in public schools had significantly higher vaccination coverage levels for Var2, 5-4-2-2-3 series, and HepA2. To further explore what may be affecting these levels; estimates were compared among counties of different population densities. Compared to urban counties, rural counties had significantly higher vaccination coverage levels for 5-4-2-2-3 series and all recommended vaccinations (Hib3, HepA2 and PCV4). These differences indicate that counties with higher school population density, such as urban schools with an average of 51 students per school, tend to have lower vaccination coverage compared to rural schools which have an average of 27 students per school; especially for recommended vaccinations.

Vaccination coverage levels were also compared among schools based on the exemption policies to determine if excluding children not UTD for required vaccinations affected coverage. It was observed that schools with policies to exclude had proportionally higher coverage levels for all required vaccines, as well as, Hib3 and PCV4 compared to schools without an exemption policy. This indicates exclusion policies may be an effective incentive for students to become UTD prior to the start of school.

Exemptions for vaccination were analyzed and 1.8% of kindergarteners reported an exemption, of which the majority were classified as religious. Religious exemptions have steadily increased for the past three school years. The percent of students with exemption did not differ between schools that exclude and those that do not (1.78% and 1.84%, respectively); however, the percentage of students with a religious exemption was greater among schools that did not exclude (1.69% vs. 1.48%). This reveals that exemption rates do not rise despite exclusion policies. Exemption rates are of particular importance because when children are exempt from vaccination or not up to date they are at risk for contracting vaccine preventable diseases (VPDs) and

subsequently spreading the disease to other unimmunized or under-immunized individuals (e.g., infants) or other high-risk persons. Therefore, it is important that the numbers of exempt and under-immunized school-aged children remain low. By having greater vaccination coverage, there is an increase in herd immunity, which leads to lower disease incidence and limits the size of VPD outbreaks. However, due to unvaccinated and under-immunized individuals, the United States has experienced increased incidence of disease; including measles which had previously been declared eliminated on January 01, 2000. In 2014 Kansas experienced an outbreak of measles that included 14 cases ranging in age from two months to 43 years. It was found that 64% of cases were either unvaccinated or unaware of vaccination status with an additional 29% too young to be vaccinated. The low MMR coverage among this group greatly contributed to the spread of this disease which requires an estimated 95% vaccination coverage for herd immunity to prevent disease.

Limitations

A limitation of this study is that vaccinations recommended for school-aged children are not required for school entry and may not be consistently reported on the vaccination record, creating a possible underreporting of coverage for Hib3, HepA2, and PCV4. Additionally, school personnel reported the number of exempt students in their school in aggregate. Therefore, KDHE was unable to verify exemptions reported. Finally, no descriptive data was collected about sex, race, or ethnicity.

While history of varicella disease may have been marked on the KCI or other vaccination record, date of disease was rarely given. Without knowing the date of disease, it cannot be definitively determined that the disease took place before the first scheduled dose of varicella containing vaccine. Children with marked history of disease, regardless of number of varicella vaccinations were not included in analysis for varicella coverage. Of the 6,748 records analyzed, 36 (0.5%) were recorded as having disease history and removed from varicella coverage analysis.

Strengths

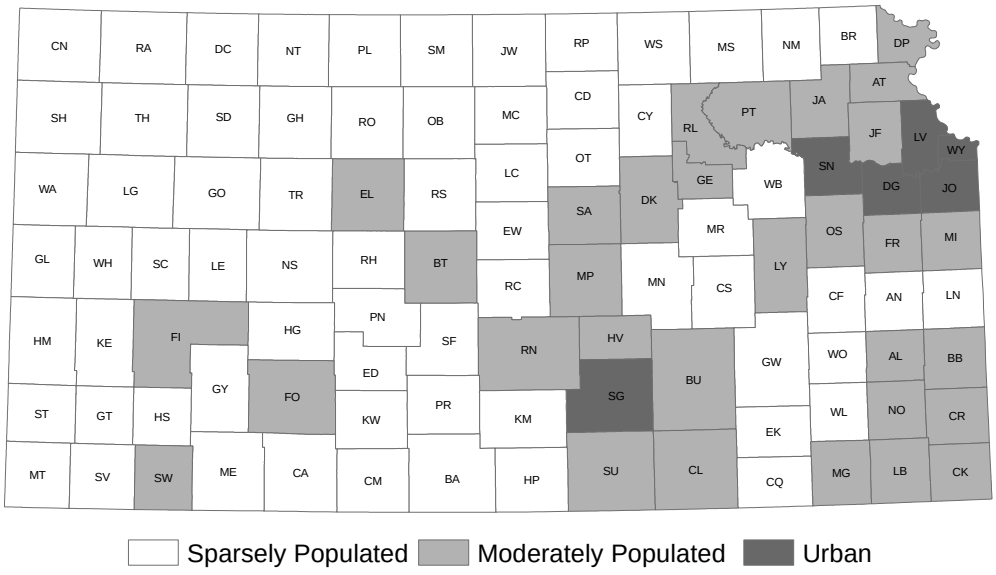
Despite the limitations, this annual vaccination survey provided a good estimation of vaccination coverage for kindergarten children enrolled in public and private schools in Kansas. This document allows state and local officials to identify counties and regions with low vaccine coverage levels to focus implementation of enhanced vaccination delivery methods and educational campaigns that can aid in Kansas achieving national vaccination coverage metrics. This study also had a high response percentage in terms of survey participation. This included response levels among schools that received requests for vaccination records (80%) and schools that received requests for exemption data (68%).

Appendix 1: Kansas counties categorized based on population density, 2010

Sparsely Populated	
Anderson	Marshall
Barber	Meade
Brown	Mitchell
Chase	Morris
Chautauqua	Morton
Cheyenne	Nemaha
Clark	Ness
Clay	Norton
Cloud	Osborne
Coffey	Ottawa
Comanche	Pawnee
Decatur	Phillips
Edwards	Pratt
Elk	Rawlins
Ellsworth	Republic
Gove	Rice
Graham	Rooks
Grant	Rush
Gray	Russell
Greeley	Scott
Greenwood	Sheridan
Hamilton	Sherman
Harper	Smith
Haskell	Stafford
Hodgeman	Stanton
Jewell	Stevens
Kearny	Thomas
Kingman	Trego
Kiowa	Wabaunsee
Lane	Wallace
Lincoln	Washington
Linn	Wichita
Logan	Wilson
Marion	Woodson

Moderately Populated	
Allen	Jackson
Atchison	Jefferson
Barton	Labette
Bourbon	Lyon
Butler	McPherson
Cherokee	Miami
Cowley	Montgomery
Crawford	Neosho
Dickinson	Osage
Doniphan	Pottawatomie
Ellis	Reno
Finney	Riley
Ford	Saline
Franklin	Seward
Geary	Sumner
Harvey	

Urban
Douglas
Johnson
Leavenworth
Sedgwick
Shawnee
Wyandotte



Persons per Square Mile in Peer Groups
Sparsely Populated = ≤19.9
Moderately Populated = 20 – 149.9
Urban = ≥ 150.0

Appendix 2: Average school vaccination coverage levels for children at school entry for Kansas counties, 2016-2017 (percentages) [§]

COUNTY	DTaP5*	Polio4♦	MMR2	Var2	HepB3	5-4-2-2-3	Hib3	PCV4	HepA2
STATEWIDE	**89%**	**88%**	**89%**	**88%**	**97%**	**83%**	**92%**	**83%**	**91%**
ALLEN	97%	98%	98%	98%	97%	93%	99%	91%	98%
ANDERSON	89%	86%	90%	87%	96%	86%	87%	87%	82%
ATCHISON	89%	87%	90%	90%	99%	86%	97%	90%	93%
BARBER	90%	90%	88%	88%	98%	84%	98%	87%	96%
BARTON	94%	90%	93%	93%	98%	87%	98%	93%	96%
BOURBON	93%	87%	94%	93%	96%	83%	99%	70%	90%
BROWN	98%	96%	98%	94%	100%	92%	98%	80%	96%
BUTLER	89%	87%	90%	89%	93%	82%	96%	84%	90%
CHASE	87%	91%	91%	87%	91%	83%	83%	83%	87%
CHAUTAUQUA	82%	76%	71%	68%	94%	62%	85%	91%	85%
CHEROKEE	85%	86%	86%	87%	95%	80%	93%	81%	88%
CHEYENNE	57%	57%	71%	71%	86%	57%	86%	86%	100%
CLARK	84%	86%	86%	84%	100%	84%	100%	89%	97%
CLAY	94%	94%	94%	94%	94%	91%	94%	91%	94%
CLOUD	92%	91%	92%	89%	100%	88%	95%	79%	95%
COFFEY	72%	72%	72%	72%	89%	59%	93%	85%	93%
COMANCHE	97%	97%	100%	100%	100%	97%	97%	77%	93%
COWLEY	87%	86%	86%	86%	96%	82%	93%	79%	92%
CRAWFORD	80%	79%	83%	81%	92%	73%	83%	52%	80%
DECATUR	90%	90%	93%	93%	100%	90%	83%	83%	93%
DICKINSON	92%	90%	89%	94%	95%	80%	95%	83%	95%
DONIPHAN	94%	93%	94%	94%	99%	93%	97%	94%	97%
DOUGLAS	87%	86%	88%	85%	95%	79%	88%	74%	91%
EDWARDS	100%	95%	95%	100%	100%	92%	97%	87%	97%
ELK	86%	83%	86%	86%	100%	80%	97%	83%	97%
ELLIS	93%	92%	94%	94%	98%	91%	94%	74%	97%
ELLSWORTH	82%	86%	86%	88%	100%	77%	88%	82%	98%
FINNEY	89%	88%	88%	88%	99%	85%	96%	85%	95%
FORD	88%	88%	88%	87%	97%	84%	94%	90%	91%
FRANKLIN	90%	90%	90%	89%	97%	85%	92%	78%	91%
GEARY	89%	87%	90%	90%	97%	82%	93%	85%	96%
GOVE	75%	75%	75%	75%	100%	69%	94%	88%	88%
GRAHAM	100%	100%	100%	100%	100%	100%	100%	100%	100%
GRANT	100%	97%	97%	100%	100%	93%	97%	90%	100%
GRAY	89%	92%	92%	92%	95%	86%	97%	87%	95%
GREELEY	95%	86%	95%	95%	100%	86%	95%	90%	95%
GREENWOOD	86%	88%	88%	88%	95%	86%	93%	84%	90%
HAMILTON	100%	100%	97%	97%	97%	97%	93%	83%	93%
HARPER	90%	87%	87%	87%	99%	81%	98%	90%	84%
HARVEY	89%	93%	94%	92%	98%	83%	95%	88%	94%
HASKELL	86%	90%	90%	92%	95%	85%	95%	88%	93%
HODGEMAN	84%	84%	84%	83%	100%	84%	100%	96%	96%
JACKSON	94%	93%	94%	95%	99%	87%	97%	91%	97%

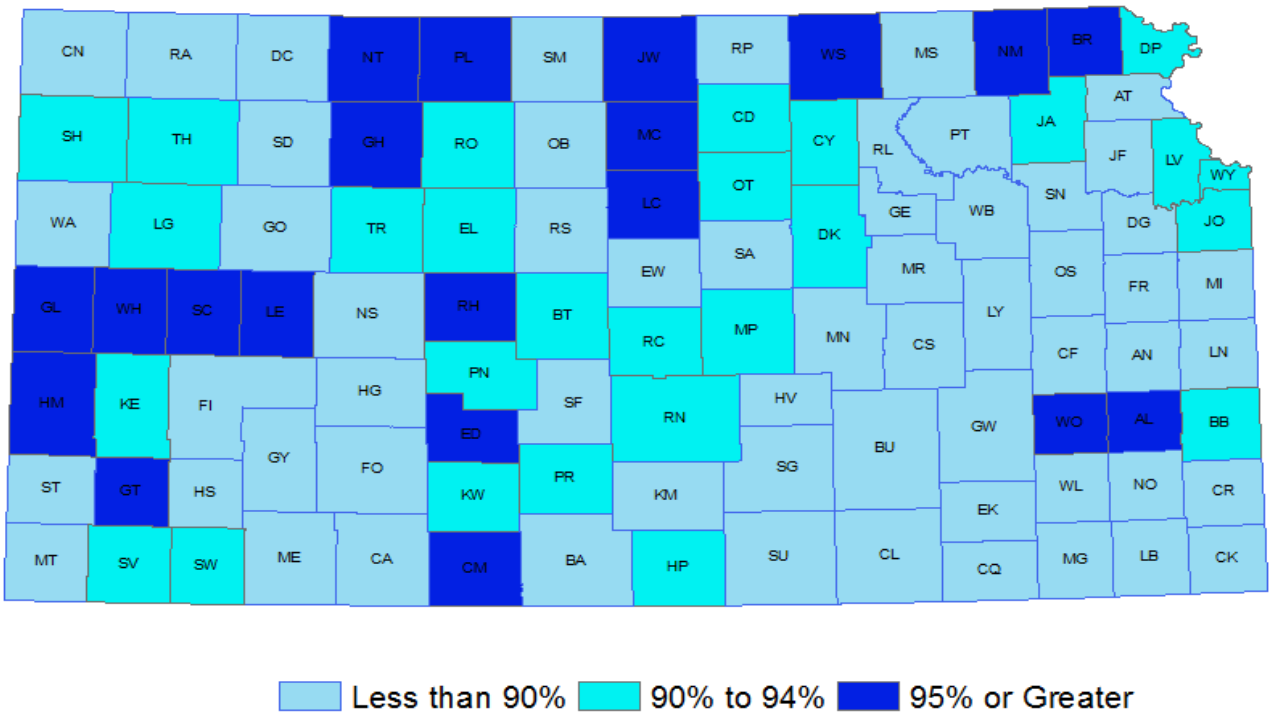
COUNTY	DTaP5*	Polio4♦	MMR2	Var2	HepB3	5-4-2-2-3	Hib3	PCV4	HepA2
STATEWIDE	**89%**	**88%**	**89%**	**88%**	**97%**	**83%**	**92%**	**83%**	**91%**
JEFFERSON	88%	88%	91%	89%	95%	79%	94%	83%	97%
JEWELL	95%	100%	100%	100%	100%	95%	95%	95%	90%
JOHNSON	93%	92%	94%	93%	98%	86%	93%	84%	94%
KEARNY	91%	91%	92%	93%	97%	87%	90%	88%	95%
KINGMAN	86%	87%	91%	92%	89%	79%	93%	86%	88%
KIOWA	91%	91%	88%	91%	93%	86%	93%	91%	88%
LABETTE	84%	95%	89%	88%	94%	72%	95%	84%	95%
LANE	100%	100%	100%	100%	100%	100%	100%	100%	100%
LEAVENWORTH	93%	87%	94%	93%	97%	82%	94%	84%	88%
LINCOLN	100%	100%	100%	100%	100%	100%	100%	100%	100%
LINN	89%	90%	94%	89%	94%	82%	95%	83%	88%
LOGAN	91%	83%	89%	86%	100%	83%	100%	100%	100%
LYON	68%	80%	68%	66%	94%	63%	96%	94%	93%
MARION	82%	84%	89%	88%	96%	76%	93%	85%	94%
MARSHALL	88%	88%	88%	86%	95%	82%	93%	95%	98%
MCPHERSON	90%	92%	92%	92%	94%	87%	55%	50%	93%
MEADE	81%	81%	81%	81%	100%	68%	100%	84%	97%
MIAMI	80%	86%	85%	84%	93%	78%	44%	40%	91%
MITCHELL	96%	90%	96%	91%	99%	86%	97%	90%	99%
MONTGOMERY	87%	89%	90%	88%	94%	83%	93%	72%	80%
MORRIS	65%	71%	65%	65%	100%	65%	94%	88%	82%
MORTON	88%	93%	100%	93%	81%	56%	93%	67%	87%
NEMAHA	96%	93%	98%	96%	98%	87%	94%	84%	100%
NEOSHO	86%	90%	89%	86%	100%	80%	99%	9%	86%
NESS	79%	79%	70%	68%	93%	70%	93%	61%	68%
NORTON	98%	96%	98%	98%	100%	96%	97%	97%	100%
OSAGE	80%	77%	83%	83%	100%	73%	97%	80%	90%
OSBORNE	83%	90%	83%	83%	93%	80%	97%	93%	90%
OTTAWA	90%	90%	93%	93%	93%	80%	93%	73%	97%
PAWNEE	92%	89%	89%	86%	97%	83%	94%	94%	97%
PHILLIPS	100%	97%	100%	100%	100%	97%	100%	100%	100%
POTTAWATOMIE	88%	91%	94%	94%	94%	81%	88%	88%	93%
PRATT	94%	98%	94%	94%	100%	91%	98%	87%	100%
RAWLINS	87%	96%	96%	96%	100%	87%	91%	91%	100%
RENO	94%	95%	94%	94%	98%	91%	94%	82%	95%
REPUBLIC	71%	71%	71%	71%	93%	71%	93%	93%	89%
RICE	91%	91%	89%	89%	96%	85%	92%	85%	94%
RILEY	89%	90%	88%	88%	98%	85%	83%	73%	80%
ROOKS	93%	93%	93%	93%	100%	93%	100%	100%	100%
RUSH	100%	100%	100%	100%	100%	100%	100%	100%	90%
RUSSELL	86%	89%	90%	90%	99%	86%	95%	93%	94%
SALINE	83%	82%	85%	79%	99%	77%	97%	87%	94%
SCOTT	100%	100%	100%	100%	97%	97%	100%	93%	100%
SEDGWICK	86%	87%	86%	87%	96%	77%	93%	83%	88%
SEWARD	93%	91%	94%	89%	97%	83%	94%	81%	92%
SHAWNEE	83%	85%	84%	83%	93%	74%	90%	86%	91%

COUNTY	DTaP5*	Polio4♦	MMR2	Var2	HepB3	5-4-2-2-3	Hib3	PCV4	HepA2
STATEWIDE	**89%**	**88%**	**89%**	**88%**	**97%**	**83%**	**92%**	**83%**	**91%**
SHERIDAN	70%	70%	75%	75%	100%	70%	100%	95%	100%
SHERMAN	93%	93%	97%	93%	100%	90%	97%	93%	97%
SMITH	80%	80%	100%	100%	100%	80%	80%	80%	100%
STAFFORD	76%	79%	79%	76%	88%	73%	91%	88%	94%
STANTON	82%	89%	89%	89%	89%	79%	93%	82%	93%
STEVENS	94%	93%	94%	94%	97%	90%	97%	93%	96%
SUMNER	80%	80%	78%	78%	91%	73%	87%	78%	85%
THOMAS	91%	86%	91%	84%	95%	80%	96%	91%	91%
TREGO	93%	93%	93%	90%	100%	90%	93%	93%	100%
WABAUNSEE	88%	88%	94%	80%	81%	69%	94%	88%	75%
WALLACE	74%	74%	74%	74%	97%	65%	90%	84%	87%
WASHINGTON	95%	95%	95%	95%	95%	90%	95%	90%	90%
WICHITA	100%	100%	100%	100%	100%	100%	100%	93%	100%
WILSON	87%	80%	87%	90%	94%	70%	94%	77%	89%
WOODSON	97%	90%	97%	97%	100%	90%	97%	83%	93%
WYANDOTTE	92%	85%	95%	90%	96%	75%	84%	72%	89%

§ Due to Hib3, HepA2, and PCV4 not being required for school entry, these vaccines may not consistently be reported on the vaccination record, thus decreasing coverage levels for the individual vaccines. This is evident for several counties that have extremely low levels for the Hib3, HepA2 and PCV4 coverage levels.
*5 doses of DTaP or 4 doses if the fourth is administered on or after the fourth birthday.
♦4 doses of Polio or 3 doses if 3rd is administered on or after the fourth birthday

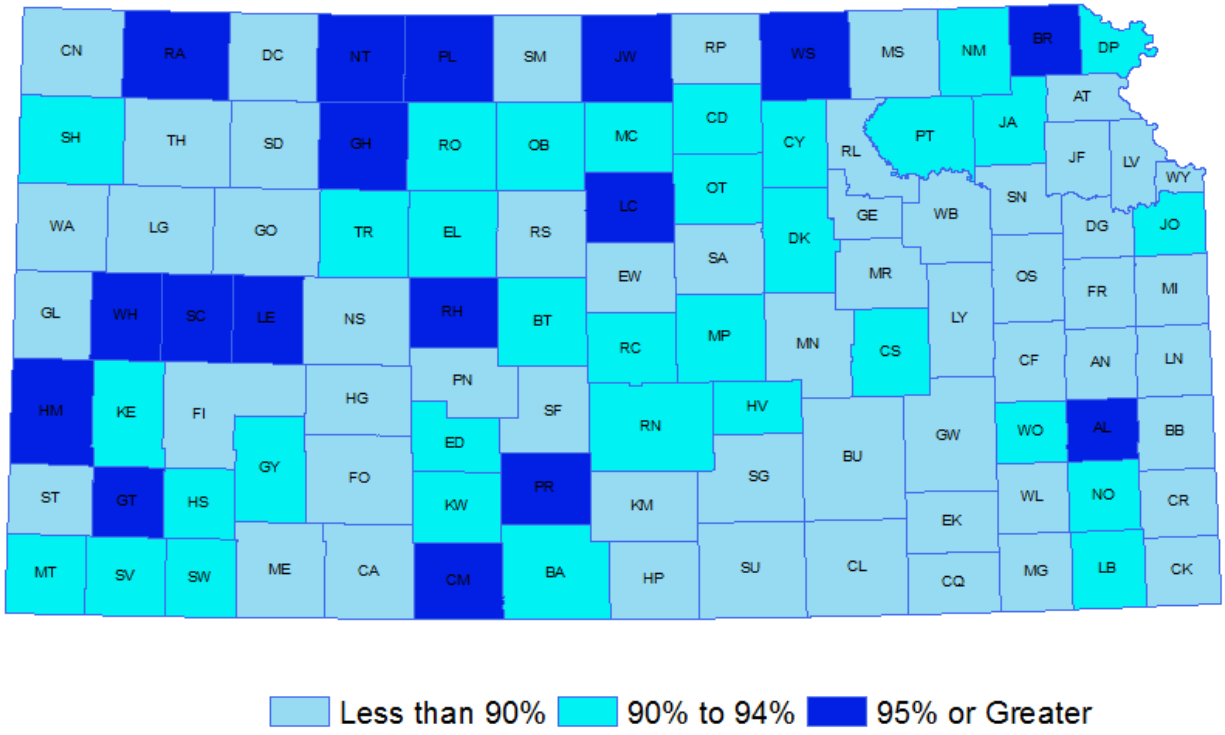
Appendix 3: Maps of vaccination levels by county, 2016-2017 Kindergarten Survey

DTaP5 Coverage for Kindergarten Survey, 2016-2017



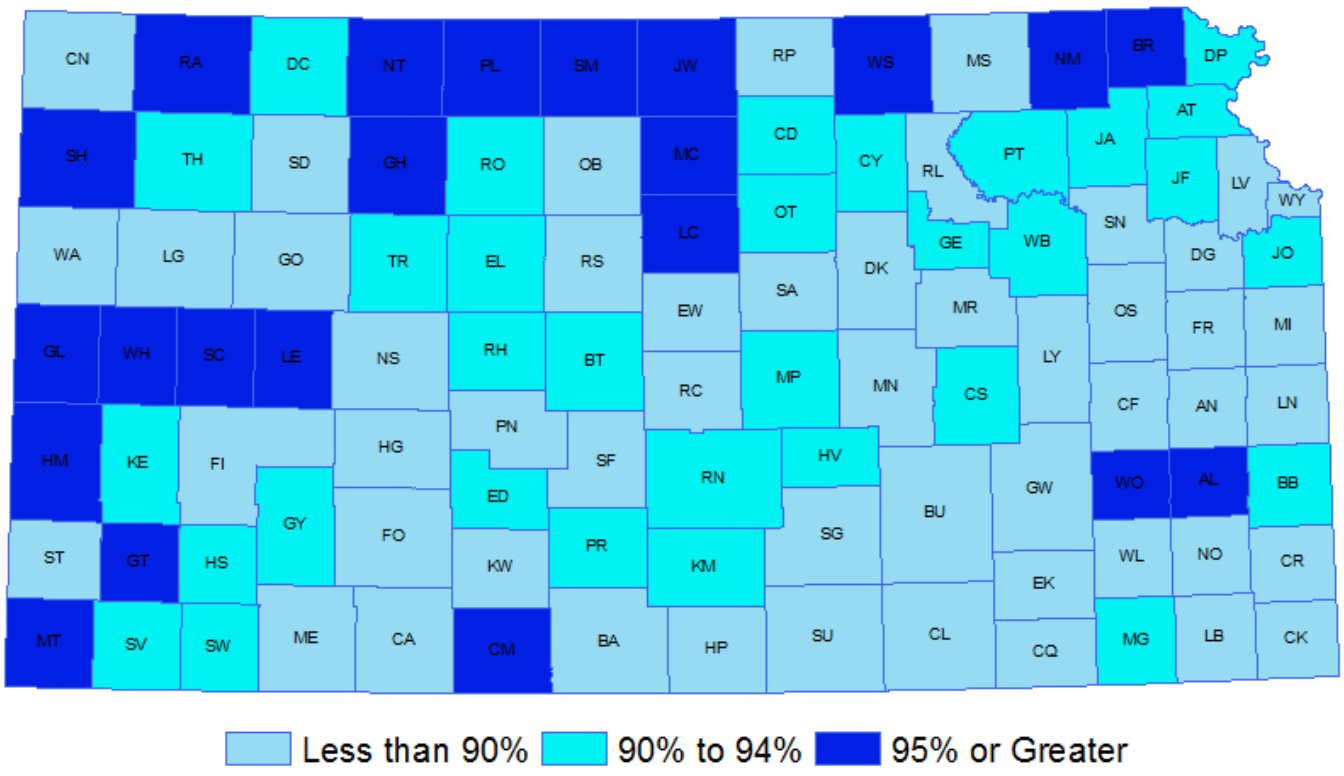
5 doses of DTaP or 4 doses if the fourth is administered on or after the fourth birthday

Polio4 Coverage for Kindergarten Survey, 2016-2017

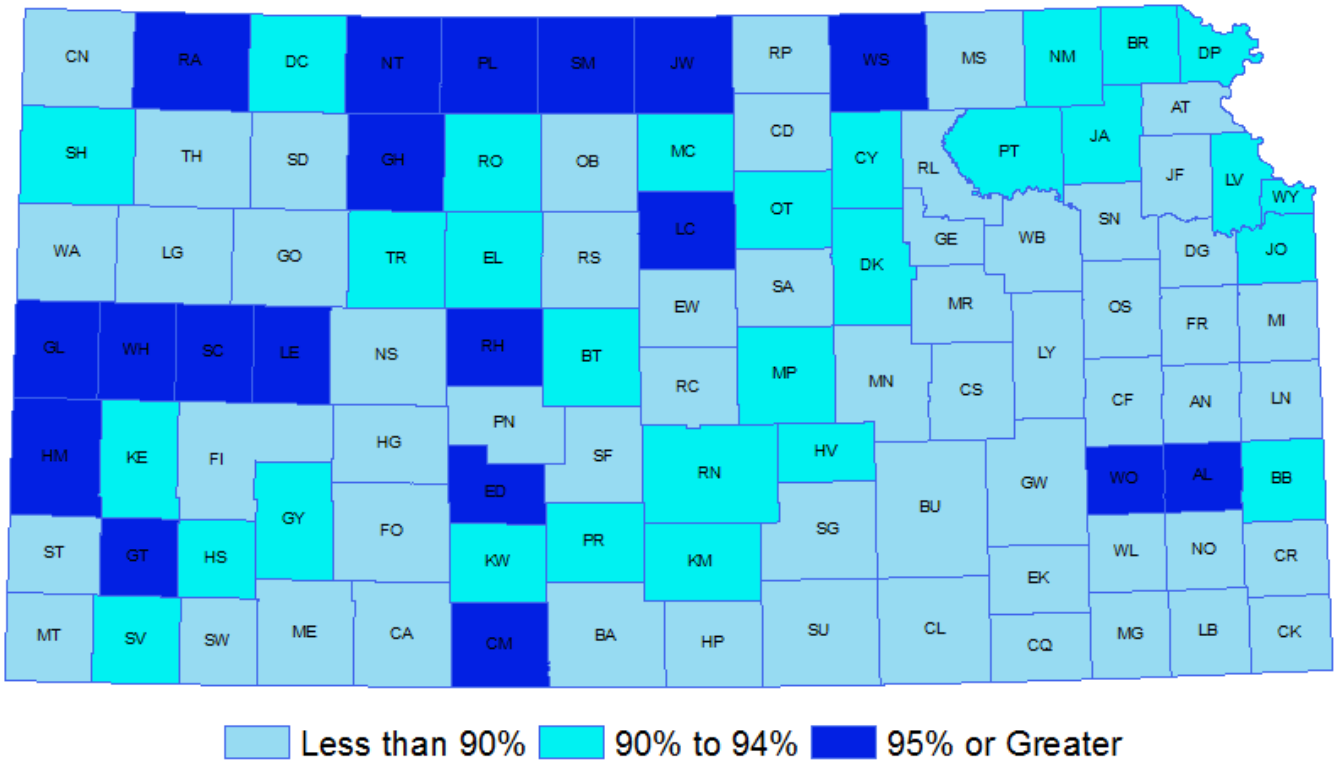


4 doses of Polio or 3 doses if 3rd is administered on or after the fourth birthday

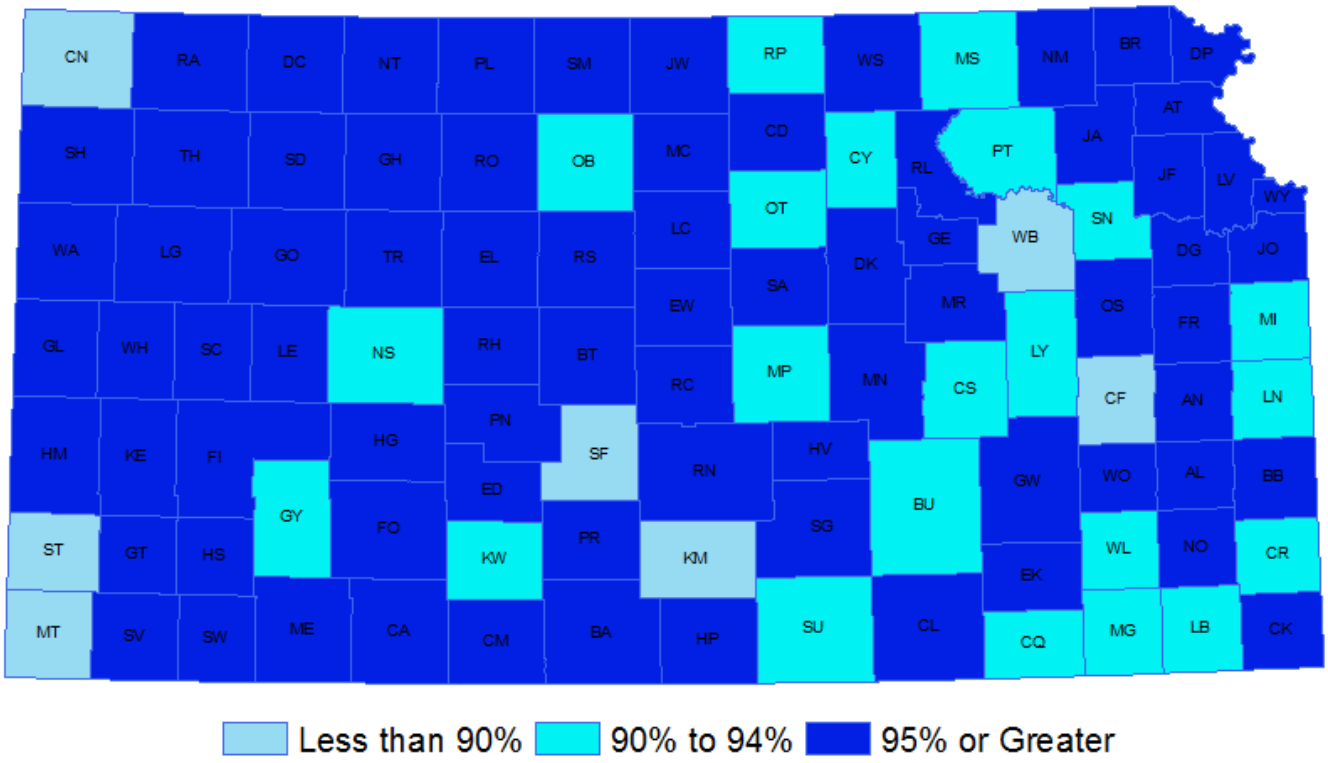
MMR2 Coverage for Kindergarten Survey, 2016-2017



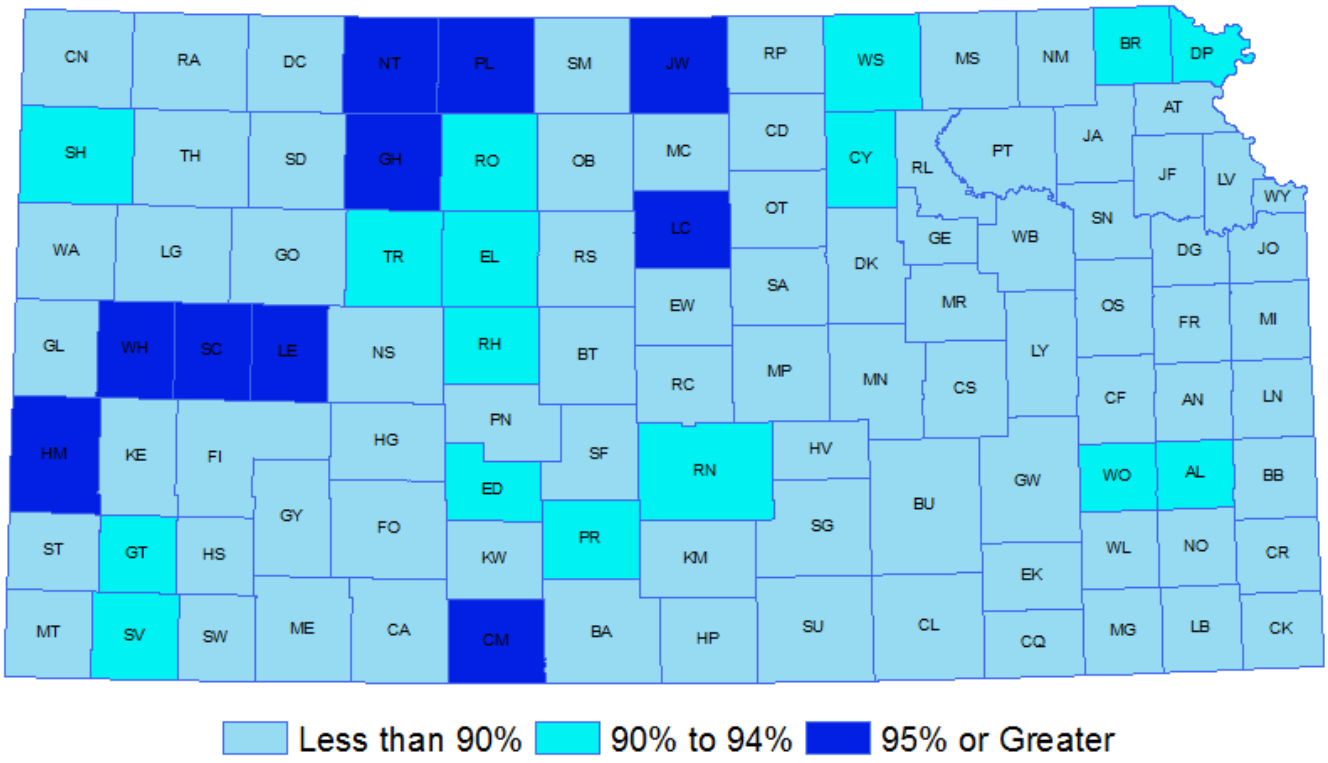
Var2 Coverage for Kindergarten Survey, 2016-2017



HepB3 Coverage for Kindergarten Survey, 2016-2017

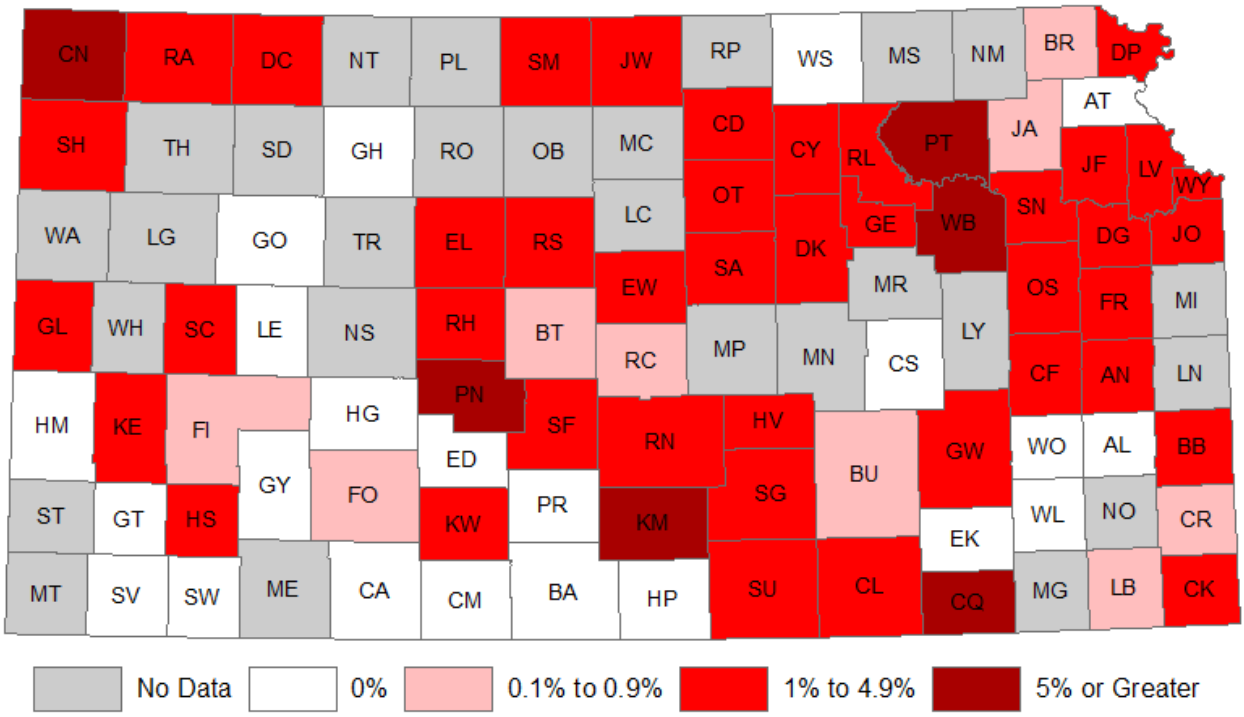


5-4-2-2-3 Coverage for Kindergarten Survey, 2016-2017

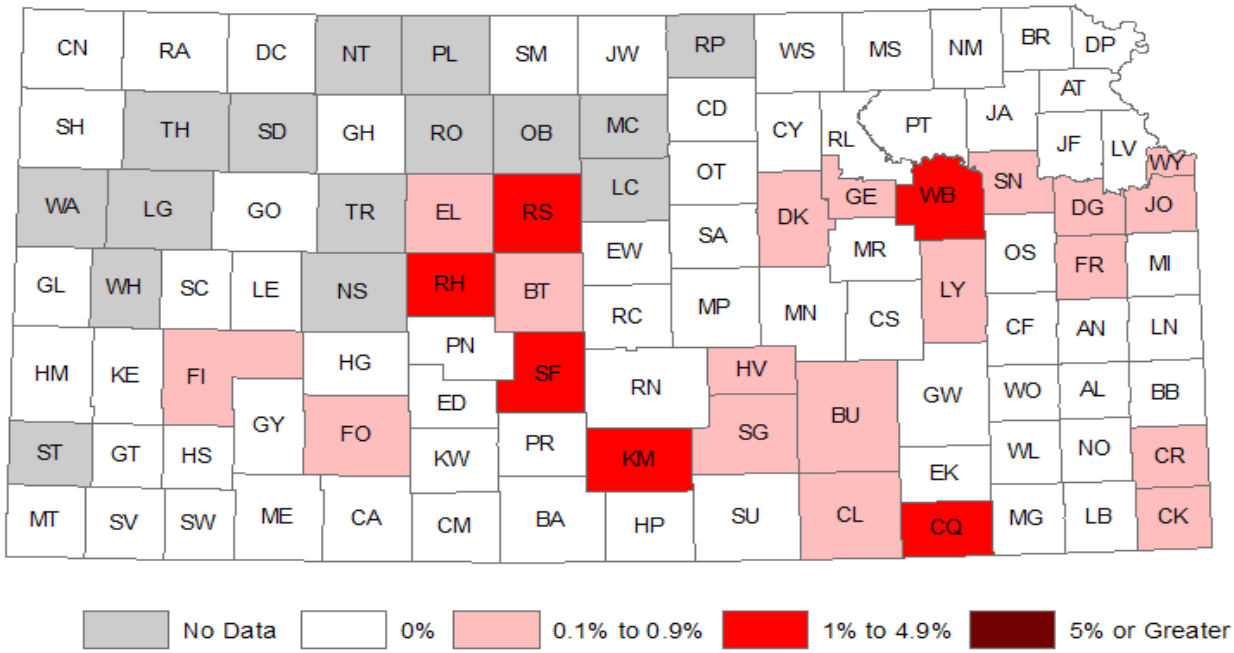


Appendix 4: Maps of exemptions by county, 2016-2017 Kindergarten Survey

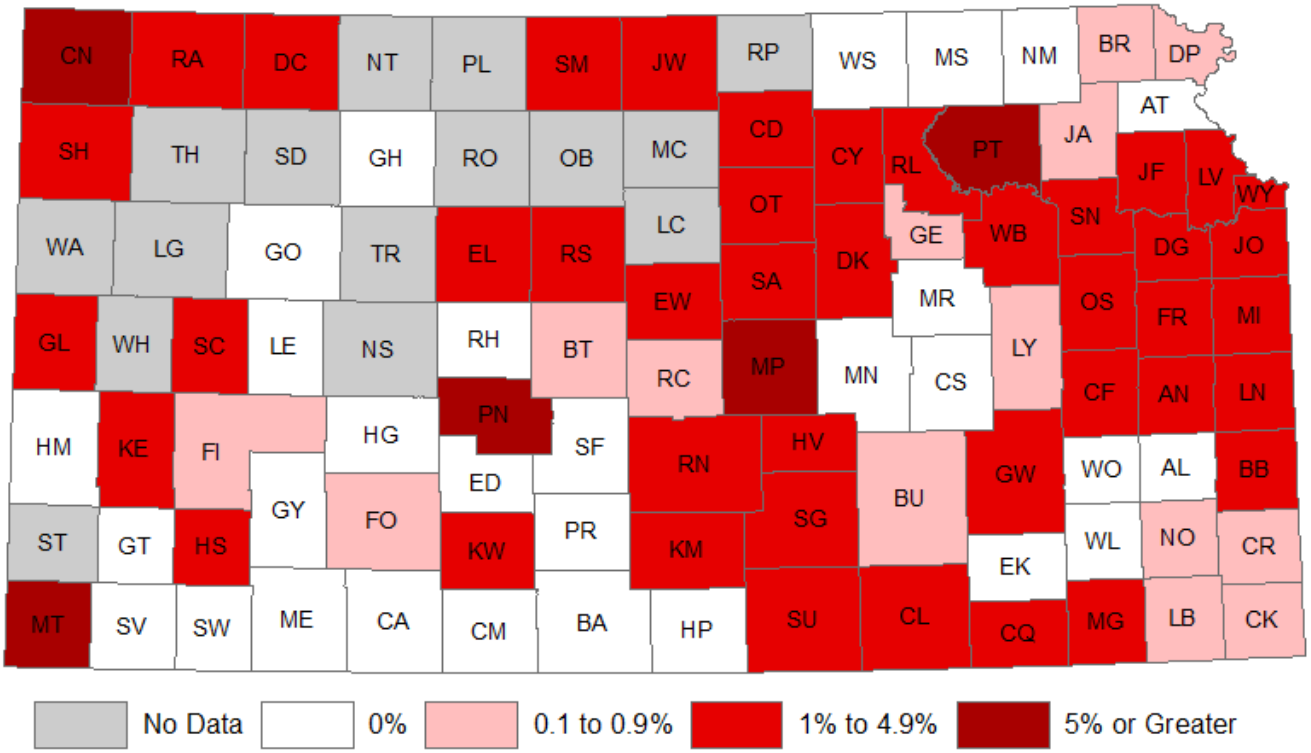
Percent of Kindergartners Exempt by County, 2016-2017



Percent of Kindergartners with a Medical Exemption by County, 2016-2017



Percent of Kindergartners with a Religious Exemption at Submitting Schools by County, 2016-2017



Includes children enrolled at both public and private schools

Appendix 5: CDC's Advisory Committee on Vaccination Practices (ACIP) Recommendations https://www.cdc.gov/vaccines/schedules/downloads/child/0-18yrs-child-combined-schedule.pdf

Figure 1. Recommended Immunization Schedule for Children and Adolescents Aged 18 Years or Younger—United States, 2017.

(FOR THOSE WHO FALL BEHIND OR START LATE, SEE THE CATCH-UP SCHEDULE [FIGURE 2]).

These recommendations must be read with the footnotes that follow. For those who fall behind or start late, provide catch-up vaccination at the earliest opportunity as indicated by the green bars in Figure 1. To determine minimum intervals between doses, see the catch-up schedule (Figure 2). School entry and adolescent vaccine age groups are shaded in gray.